APPLE CULTURE IN OHIO

OHIO
Agricultural Experiment Station

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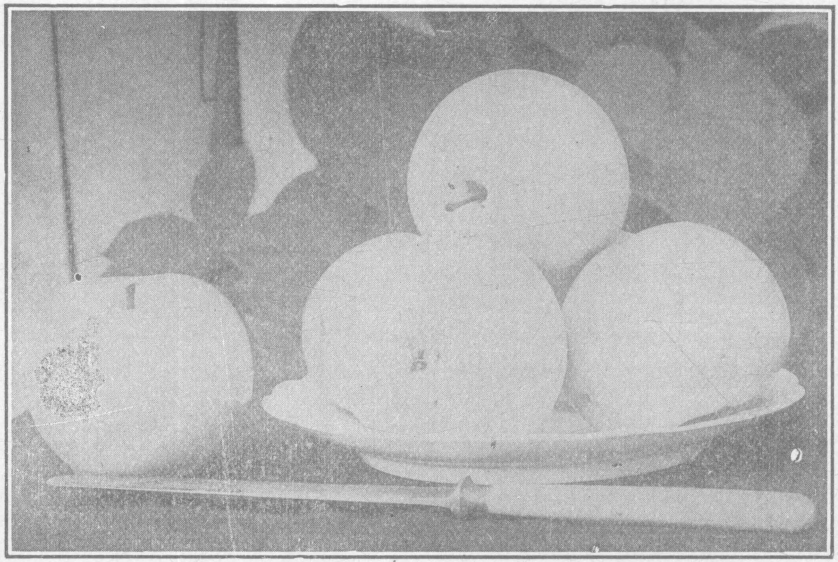

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[1]In cooperation with the College of Agriculture, Ohio State University, Columbus.
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BULLETIN

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APPLE CULTURE IN OHIO

By F. H. BALLOU

APPLE GROWING IN OHIO—PAST, PRESENT, PROSPECTIVE

We may divide the history of apple growing in Ohio into three epochs: First, the period of abundance and encouragement; second, the period of adversity and perplexity; third, the period of awakening and restoration. The first period is past; we are emerging from the dark, dispiriting years of the second into the cheering dawn of the third—a period of general reconstruction, upon a broad and substantial basis, of an industry that will not only endure, but will, through aid of modern scientific methods, perform its part in winning for Ohio fame as a horticultural state whose heritage embraces every requisite, natural resource.

It is well for us to give thought, in a practical, common-sense way, to a situation so fraught with interesting facts and wholesome lessons as the history of apple culture in Ohio. What a familiar story it is—of the early years when the virgin soil of plain, hill and dale brought forth fruit in generous abundance; when glowing, golden and ruby apples in unblemished perfection bent in rainbow curves the strong branches of healthy trees whose foliage was of deepest green; when little effort was rewarded with great returns; when the substantial income of welcome dollars, gained through the sale of surplus fruit rendered the new-born industry of considerable importance in various sections of Ohio; when no thought seemed necessary to be devoted to the future physical needs of the trees nor to the possibility of grave problems arising where the "balance of nature" had been disturbed by so radical a measure as

removing large areas of native vegetation and planting special crops. These, indeed, were the years of revelation—years abounding in clearly demonstrated lessons relative to the resources of the new country and the innate power of youthful Ohio's soil and climate, unhampered by adverse, superficial influences, to produce beautiful, sound, perfect fruits.

Then gradually came the shadows of the period of perplexity and discouragement—the years which brought with them trial of human faith and resource; years in which the scientist was untiring and hopeful in experiment and research, and a few undaunted, wide-a-wake orchardists alert and attentive, faithfully keeping abreast with scientific progress; years in which unobservant, indifferent, faint-hearted orchard owners were puzzled or skeptical. The advent of this period of confusion had its origin in the stealthy appearance of insect foes infesting the foliage and fruits of the apple, and which multiplied and spread until the destruction wrought was state-wide and alarming in intensity. No less a scourge became the various fungous and bacterial diseases which later appeared and became so disastrously prevalent, sweeping through the orchards of hill and vale and spreading their blighting, gnarling infection throughout Ohio. The once beautiful and prolific orchards, in numberless instances, came to be regarded as problematical incumbrances of the ground rather than profitable adjuncts of the farm as in the early years. As a result of the discouragement occasioned by serious insect and fungous parasitism, owners quite generally subjected their orchards to the additional afflictions of starvation, thirst, exposure to extremes of cold and heat and mutilation by pasturing live stock, unmodified by any system of culture that would tend to maintain fertility, conserve moisture, afford protection from extremes of temperature or the vicissitudes of the pasture-lot, meadow or corn-field into which such orchards were quite commonly converted. Thus is the closing of the period of mysterious affliction; of wonderment and gloom; of discouragement and complaint. Has discouragement been justified, and complaint well founded?

And now the dawn of awakening is upon us. The faithful orchardist, throughout the period of trial, kept his eye steadfastly upon scientific progress made in combating the enemies and obstacles in the way of successful orchard management, and applied the lessons as they became available. He succeeded financially throughout the period of depression—producing choice fruit and obtaining high prices even when the shadows of adversity were darkest over his less progressive neighbors' orchards. He has

become a leader and a missionary in his neighborhood. The truth, morever, now becomes clearly apparent that those same enemies and obstacles—the various insect pests, fungous diseases, and waning vigor of uncultivated, unfed, unpruned orchards—actually constituted a blessing in disguise. Had the days of universal, abundant, unrestricted fruitage continued as in the early period of orchard planting, when no special effort need be put forth in order to insure rich harvests, there would today be no premium fixed upon superior, individual intelligence, progressiveness and industry. The careless and indolent person would gather from his land rewards equal to those of his wide-a-wake, industrious neighbor who studies to win and toils to produce a superior product and to place it upon the market in attractive form. Such condition, indeed, would render impossible the developement or continuity of such an institution as an appreciative, discriminating, merit-rewarding public market.

Therefore let us reassure and fortify ourselves with this simple, fundamental truth, that a wise and considerate Providence purposely exhibited to us during an early and ample period of time that is now gone forever, the wonderful possibilities of our great state in the production of beautiful, luscious apples and other fruits, unrestricted by the limiting factors which were to come. Not by any means, nor for a single moment should we entertain the belief that such a marvellous object-lesson came by chance. God simply revealed to us, through the medium of nature, the power of our soil and the suitability of our climate to produce fine, perfect fruit when the necessary conditions were met, that those who might observe would give serious thought to these possibilities, and that in the future they might be encouraged and determined to intelligently combat and subdue when restrictive enemies and barriers to success should appear.

The ample period of that clear-cut, practical revelation has passed. Scientific study and experiment by earnest, thoughtful men have developed, and are still perfecting, methods of control of the numerous insect foes and fungous diseases which have come in the course of time to render more profitable the earnest endeavor of the faithful horticulturist, and to eliminate from competition the thoughtless, careless negligent orchard owner.

There is, indeed, a great awakening. Help is being sought in various parts of our state. The sentiment is growing—and with substantial foundation—that we have within the boundaries of our own good state "a land of big, red apples" second to none in this or any other country. We are, therefore, in the midst of an active

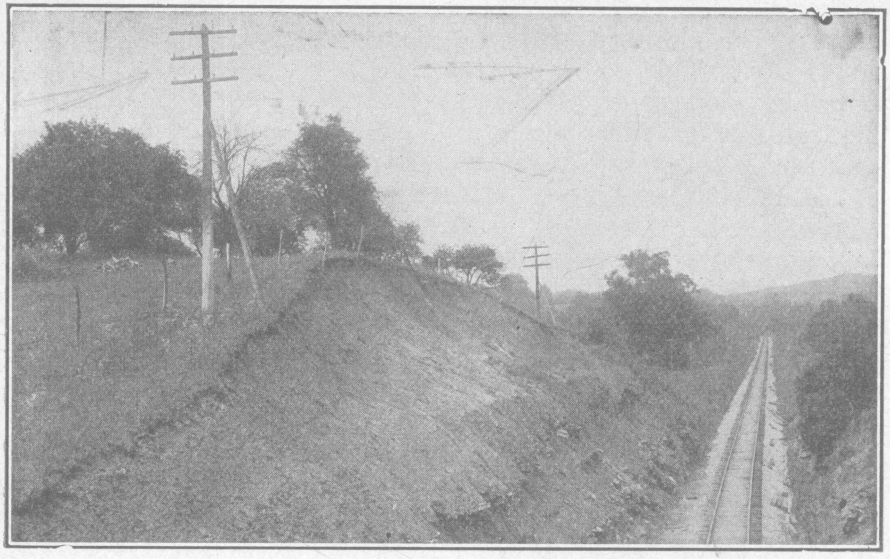
educational campaign in which our state institutions—educational and experimental—are laboring "shoulder to shoulder." There is but one recognized goal for the future: That Ohio shall take her rightful place among the leading apple growing states of our Union. Which means that there shall be a development of the latent resources not only of hundreds of our hitherto discouraged land owners, but of thousands of acres of our idle lands in the rougher portions of Ohio.

THE ESSENTIALS OF SUCCESSFUL APPLE CULTURE

Apple culture of the present day depends upon a number of factors each of which determines, to a greater or lesser extent, the degree of success which may be attained. The principal points to be taken into consideration by the prospective planter or purchaser of an orchard may be named as follows: Location, elevation, soil, varieties, planting, culture, pruning, spraying and thinning. The greatest determining factors of all, however, are the personal qualities of the orchardist himself. The man who is fitted by nature, inclination and more or less thoughtful, careful preparation for horticultural work, will succeed under somewhat adverse conditions, while his neighbor in whom there is tendency toward thoughtless, careless habits and lack of interest will fail even under much more favorable environment.

Location of the orchard

It is a great advantage if an orchard situation may be within convenient reach of a good shiping point. Ohio is especially well provided with a great system of railroads, one or more lines of which reach every county of the state. The extension of interurban electric railroads has also done much to multiply desirable orchard sites. The border counties of eastern and southern Ohio possess excellent facilities for river transportation which is now assured of substantial improvement from year to year. Greater still is the advantage if an orchard be situated within driving distance of one of the many thriving cities of Ohio. For the smaller orchardist, especially, a good home market is found in every city and village of the state; moreover, many farmers prefer to devote their attention wholly to their own specialties and buy fruit rather than to grow it. There are many thousands of acres of idle lands in Ohio, unsuited to agricultural purposes, lying adjacent to great railway lines, which are admirably situated for extensive orchard work, and the time is coming when all these vast areas of idle lands will be required to perform a part in producing the food supply of our rapidly increasing population.



A southern Ohio railroad which passes through a country abounding in excellent sites for commercial apple orchards. Tens of thousands of acres of idle land lie along the right-of-way of this and other southern Ohio railroads

Elevation

While apples may be grown with some success in level sections of the state, it is a very great advantage if the site chosen for the orchard be somewhat higher than the land adjacent. An elevation of even a few feet above the channels or beds of local streams of water will provide not only the necessary water drainage, but also favor frost or cold air drainage which is of almost equal importance. It is a generally well known fact that, under weather conditions which favor frost, the colder atmosphere being the heavier seeks the lower levels of the valleys, ravines and depressions, while the warmer, lighter air envelopes the slopes and summits of the higher ground, often entirely preventing injury by frost in late spring, to the blossoms or young fruit. This is especially true of those areas of our state remote from the larger bodies or streams of water. The modifying and retarding influences of Lake Erie upon temperature, as affecting vegetation, renders a large area of adjacent, level land well protected from extremes of temperature. (See Circular No. 94, pp. 9-10). In the valleys of our larger rivers, such as the Ohio, Muskingum and others flowing through the rougher parts of the state and bordered along their courses by high hills on either side, it sometimes occurs, during extremely frosty weather, that the dense

river fogs protect the lower levels from frost while vegetation on the higher altitudes suffers severely. For this reason there may be exceptions made in favor of orchard sites on the more elevated portions of "second bottom" land of some of the greater river valleys, as that of the Ohio; but this will not generally apply to the much smaller valleys of the lesser tributaries. Excessive humidity, in the valleys of the great streams of water, favors the development of certain forms of fungi affecting the apple —such as the "sooty blotch" or fungus— which are rarely troublesome on the more elevated sites. As a rule, the preference of location for an apple orchard would wisely be given to the elevated hill-slope or summit.

Soil

Admitting the truth that apples are being successfully grown, in some parts of Ohio, on soil so poor that it would not produce 10 bushels of corn per acre, it is at the same time true that in order to secure healthy, vigorous, well-grown trees, which will devote a long life to generous fruit-bearing, there must be in the soil those elements which constitute fertility and good physical character. These elements, of which there are three more important, are both mineral and vegetable. Potassium and phosphorus are of mineral origin, while nitrogen is derived from the growth, breaking down and decay of vegetation—especially that class of plants belonging to the family of legumes—the clovers, peas, vetches, etc. (Bulletin No. 171, pp. 191–192).

Abundant decayed and decaying vegetable matter, within or upon the surface of the soil, is very desirable aside from the direct bearing it will have upon the nitrogen supply. A soil filled or covered with humus or vegetable fiber readily absorbs and retains a vastly greater amount of water than a soil depleted of its humus by frequent and injudicious cropping or cultivation. The humus also acts as an effective medium of insulation against extremes of cold and heat.

Culture

There are two methods of orchard culture that may be safely practiced in Ohio, which will build up and maintain the necessary supply of vegetable matter in the soil. These are: fisrt, cover-crop culture; second, mulching.

Cover-crop culture consists in annually plowing or disking the orchard area as early in the spring as the ground can be readily worked, followed by a short season of cultivation which may be done with a harrow or fine-toothed cultivator. In June cow peas or soy beans are either drilled in at the rate of three pecks or sown broad-

cast at a bushel and a half per acre, and allowed to grow, ripen and remain upon the ground over winter, to be disked or plowed under the following spring, after which the same plan is to be followed as the year preceding. An excellent plan is to drill the peas or beans with a common grain drill, stopping all but every third opening which is left wide open. This gives spaces of two feet between rows and admits of two or three very beneficial cultivations of the young plants, with a fine-toothed cultivator. Cow peas do excellently in southern Ohio, but the soy beans seem better adapted to the northern half of the state. Rye may be sown broadcast among the beans or peas in September, and lightly cultivated in. This will provide a living, winter cover-crop and an additional heavy growth of vegetation to turn under the following spring. The rye is usually permitted to grow in spring until it is nearly ready to head, before plowing under. This method of culture rapidly builds up the soil in humus content and is adapted to level or comparatively level land that can be cultivated repeatedly without loss of soil by washing. Crops of corn or potatoes may be grown in the orchard during its early years, but the ground should be manured each season or some cover-crop plowed under, in order not to deplete the soil of humus, as it will be found to be difficult to get any crop whatever to grow in the orchard after the trees reach considerable size.

The mulch method of culture consists in maintaining the orchard area in grass—the thicker and heavier the better—and heavily mulching about the trees, either with the grass which grows between them or with material of similar nature hauled in from elsewhere. The grass in the orchard is cut in June, for the first time of the season, and, if the crop be sufficently heavy, is raked, divided and thrown under the trees in a circle a little farther out than the tips of the branches extend. If the crop of grass be light it is as well to leave it upon the ground where it falls when cut, and depend upon material from outside sources with which to mulch the trees. Straw, old hay, swamp grass, broom sedge, weeds, potato vines, cornstalks or any kind of coarse, vegetable matter may thus be profitably used. This mulch, to the depth of from four to six inches, should be maintained under the outer ends of the branches of the trees by annual or biennial applications. It not only holds the rainfall and conserves the moisture in the soil, but it keeps the ground over the root systems cool in summer, prevents freezing deeply in the winter and affords, by its gradual decay, an abundant supply of plant food for the trees.

Mulched apple trees make fully as vigorous growth, bear earlier and produce fruit of firmer texture and higher color than trees under the cover-crop method. The mulch method is especially

adapted to the rough, hilly areas of our state, where serious washing of the ground would occur under any system involving frequent plowing and cultivation. (See Bul. 171 for fuller discussion of orchard culture.)

Planting

It may be well, in connection with the subject of orchard culture, to touch briefly upon the planting of young apple trees. The distance apart at which to space the trees should be governed largely by the character of the soil upon which the orchard is to be located. Where the soil is thin, as in many of the hilly sections of Ohio, 25x25 feet apart is a good distance. On richer ground the distance should be not less than 35x35 feet either way, or the equivalent. Some growers plant 25x30, while still others who have had experience with apple orchards on very fertile soil recommend not less space than 40 feet between trees either way.

If it be possible to do so it is an excellent plan for the planter to visit the nursery and see the stock before buying. If there be a nearby nursery, so much the better. Well grown trees, true to name, produced near home are as good in every way as those from more distant points—no matter what direction. Indeed it is what a tree really is and not where nor by what method it is grown, that should be the determining factor of the purchase. Budded and root-grafted trees are equally good and desirable if they are equally well grown and vigorous. It is also a good plan to purchase the trees in the autumn and heel them in where they will be secure from mice or other rodents, so that they may be at hand for planting just as soon in the spring as the ground can be worked. Or they may be safely planted in the autumn, if the work be well done. Fall planted trees should have a generous mound of soil thrown about their bases. The plan of planting peach trees in an apple orchard is not to be commended, unless the apple trees are set at wide distances apart, and then the peach trees should be set in the centers of the squares only. Apple trees, of upright growing varieties, may be more safely used as fillers than peach trees, but, as a rule, the best apple orchards are grown without fillers.

If cover crop culture be the system contemplated, the ground for the young orchard should be plowed and well prepared as for any farm crop. After carefully marking off the rows the trees are planted at the proper intersections, in holes large and deep enough to nicely accommodate the roots without bending or crowding together. If the mulch system is to be followed the ground should be carefully staked off and the holes for the trees dug in the sod, making them fully 2½ feet in diameter and 14 to 16 inches in depth,

throwing the fine, top soil to one side and the coarser subsoil to the other. The preparation of the young tree is the same in either method of planting. The rough, mutilated ends of the larger roots should be smoothly cut off with a sharp knife, and broken roots removed entirely. As is always the case in digging the trees from the nursery rows, a large part of the root system is left in the ground; therefore the tops of the young trees should be cut back severely to balance the loss of roots. Select four or five branches, so situated as to promise a well-balanced, symmetrical head, smoothly cutting all others away. The branches selected should then be cut back to from 4 to 6 strong buds.

Well grown, low-headed, two-year-old-trees are usually most satisfactory for planting, and should be set an inch or two deeper than they stood in the nursery row. In planting the trees, use the fine, top soil among and about the roots, firming well with the feet. The coarser soil is thrown upon this and left lying loosely.

If the orchard is to be tilled, cultivation should begin at once after planting. If the mulch method is the plan adopted a space three or four feet in diameter, about each tree, is at once heavily mulched with strawy manure, straw or other similar material at hand. In early autumn draw the mulch back from about the base of the tree and throw a half dozen shovelfuls of soil or cinders close up about the stem, forming a compact little mound. This precaution against the work of ground mice should be repeated each autumn—pounding down the old mound with a post tamper and adding a few more shovelfuls of soil or cinders. If there be danger from rabbits, the stems of the trees may be wrapped for the winter in building paper, or fine-meshed wire screens may be used against both mice and rabbits. (See Bul. 208).

Varieties

The following brief lists of varieties contain the names of apples which may be planted with confidence in Ohio. The varietie are named nearly in the order of their seasons of ripening—from t he earliest to the latest: Those with a * are the best for market.

FOR NORTHERN OHIO

*Yellow Transparent, *Duchess, Tetofsky, Early Harvest, Liveland Raspberry, *Maiden Blush, *Wealthy, *Grimes Golden, *Jonathan, Hubbardston, Red Canada, *Baltimore, *Baldwin, *Gano, *Stark, *Sutton Beauty, Spy, R. I. Greening.

FOR SOUTHERN OHIO

*Yellow Transparent, *Duchess, Early Harvest, Liveland Raspberry, *Maiden Blush, *Wealthy, Richard's Graft, *Grimes Golden, *Jonathan, Corp's Choice, *Rome Beauty, Ensee, *Rawles Janet, *York Imperial, *Gano, *Stayman's Winesap.

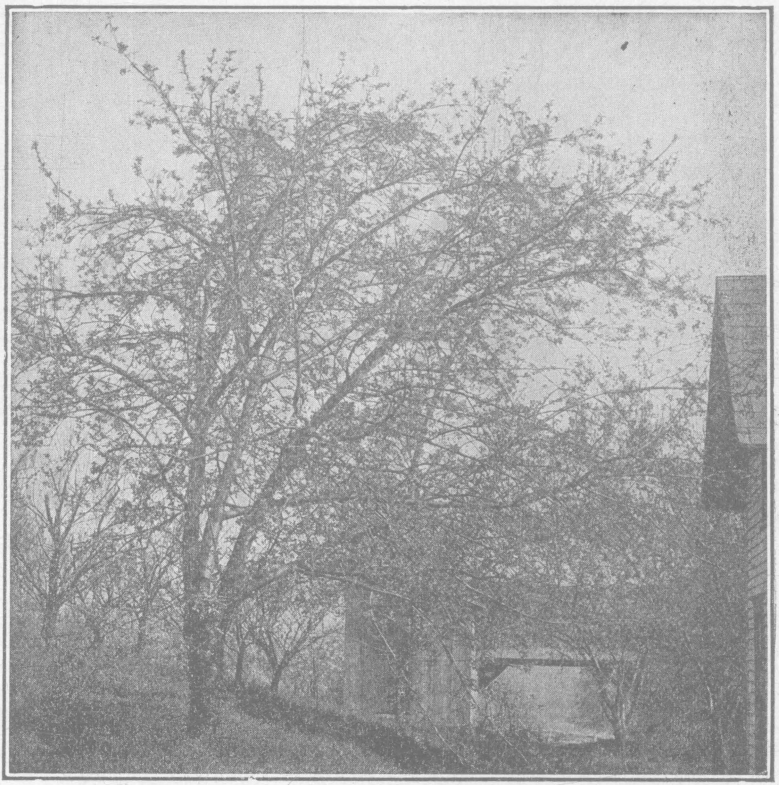
The Baldwin in northern Ohio and the Rome Beauty in the southern part of the state are probably the most popular and profitable varieties for winter market. Grimes and Jonathan should be planted freely both north and south, especially for home use and for near market.

Pruning

There can be no iron-clad rules laid down relative to the pruning of a tree. No two trees are exactly alike and each one must be treated individually. The object should be to preserve a symmetrical, well-balanced top, open in the center, without crowding of the branches in any part. All branches which grow toward the center of the tree, and those which cross or interfere with each other, should be removed. A fine-toothed pruning-saw is best for this purpose and the cuts should be made smoothly and close to the body or main branch of the tree from which the superfluous branch is pruned. There is usually a little ring or enlargement at the base of each branch; the saw-cut should be made midway and downward through this enlargement. If one branch of a tree makes an over-vigorous growth and outstrips the others, it may be cut back so as to secure uniform outlines of the head or top. The little twigs and spurs forming along the larger branches should not be cut off as the trees attain considerable size. Those very twigs and spurs are the parts of the tree which will first bear fruit.

Where branches should be cut in pruning apple trees. Such wounds readily heal

The perfect healing of a wound made by pruning away a branch



In need of attention. Wealthy apple tree grown unsymmetrical and in danger of breaking if heavily laden with fruit. Needs thinning also

Renewal of old Orchards Nearly every Ohio homestead has a greater or lesser number of old apple trees—usually of desirable varieties. As a rule they have attained such extreme size and height that it is with great difficulty that the all-important work of spraying can be accomplished. If these trees were originally headed quite low and yet retain their lower branches in fairly vigorous condition, the topmost branches may be cut back severely, lowering the height of the trees materially and rendering the work of spraying, gathering fruit, etc., much more readily done. The type of trees which cannot be successfully headed down are those which have long, naked branches extending to a considerable height before diverging into smaller branches. In heading back an old tree it is well to make the cuts just above diverging branches, if possible, as the wounds thus made will heal much more easily than if made midway between diverging branches. All wounds should be well painted with a thick, lead and oil paint.

Wealthy apple tree after heading in and thinning, its symmetry restored

Heading back large trees will result in a vigorous growth of young shoots springing up from the upper branches, and in the entire tree taking on new life. The stronger shoots in the tops of the trees should not only be thinned out each season where too thick, but those remaining after thinning should be cut back with the pruning shears from one-third to one-half their length. In a few seasons this new wood, thus restricted, will begin to form fruit buds and bear fruit. In the meantime, with thorough fertilizing, cultivation or mulching and spraying of the trees, their lower parts should be producing plenty of fine fruit. (See Bul. 180).

Spraying

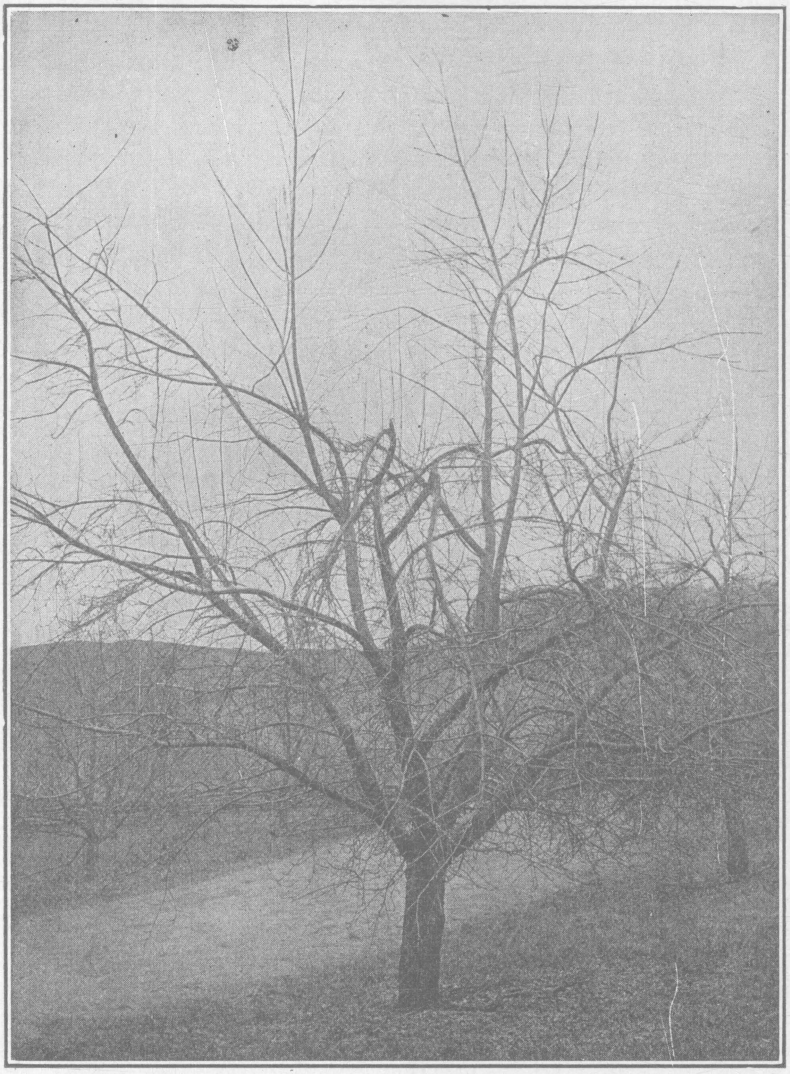
No matter how caruful may be the cultural methods employed, our orchards will fail to respond satisfactorily if the various insects and fungous diseases are not combated by spraying. Indeed, there is no orchard operation which will more largely reward thoroughness in work than spraying. We have met men who declare spraying does

not pay—for they "have tried it." But invariably close inquiry has developed the truth that they either used improperly made mixtures or failed to do the work well or at the right time. The man most difficult to convince of the benefits of spraying is the man who in the past purchased a $2.50 bucket or knapsack sprayer, used poorly prepared mixtures—perhaps mixtures entirely unsuited to the purpose—"sprinkled" a little here and a little there among his trees and, concluding it was too much work, gave it up as a failure. Such a man would be surprised to see the effective work of a really good spraying outfit and the remarkable results attending its intelligent use.

Wealthy apple tree bearing a heavy crop of fine fruit the same year of heading in.

For a number of years Bordeaux mixture has been the most efficient and popular remedy for all fungous diseases of the apple and other fruits and plants. The most prevalent and serious fungous diseases of the apple are the apple scab, the sooty fungus and various forms of rot. A veritable scourge in Ohio is the scab

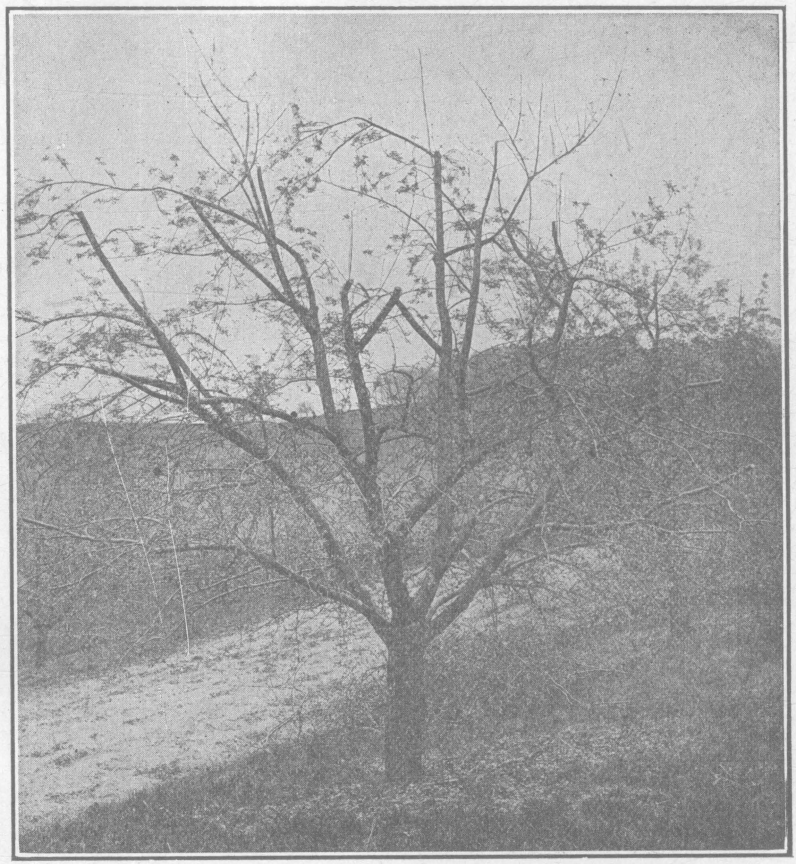
fungus—especially in seasons of excessive rainfall; yet this and all other fungous troubles can be almost entirely prevented by timely and thorough treatment with Bordeaux mixture.



A Lankford apple tree broken by heavy crop production and in need of heading in

The more destructive insects which infest the apple orchard are the San Jose scale, codling moth, canker worm and curculio The San Jose scale cannot be poisoned but must be controlled with a strong lime and sulphur spray, thoroughly applied to the trees

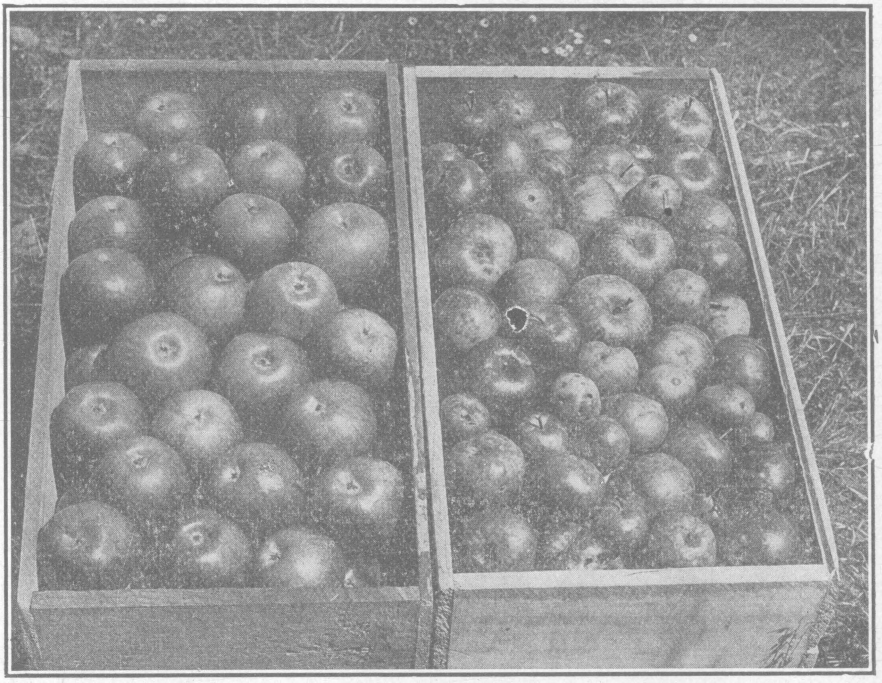
while they are dormant, preferably just as the buds are swelling in spring. The other insects named take their food by eating the tissue of the foliage or the flesh of the growing fruits, and may be readily poisoned. Various poisons have been used in the past with different degrees of success; but arsenate of lead is the approved poison at the present time, as it is not only very effective, but remarkably lasting, adhering to the foliage and fruit throughout a long, growing season without losing its efficiency. The Bordeaux mixture and the arsenate of lead are successfully combined so that both fungous and insect foes may be combated at the same time.



Lankford apple tree after heading in

The form or type of spraying outfit to be used should be determined by the amount and character of work to be accomplished. For an ordinary farm orchard of 25, 50 or 75 large trees, or a young orchard of perhaps several hundred trees, a well-made,

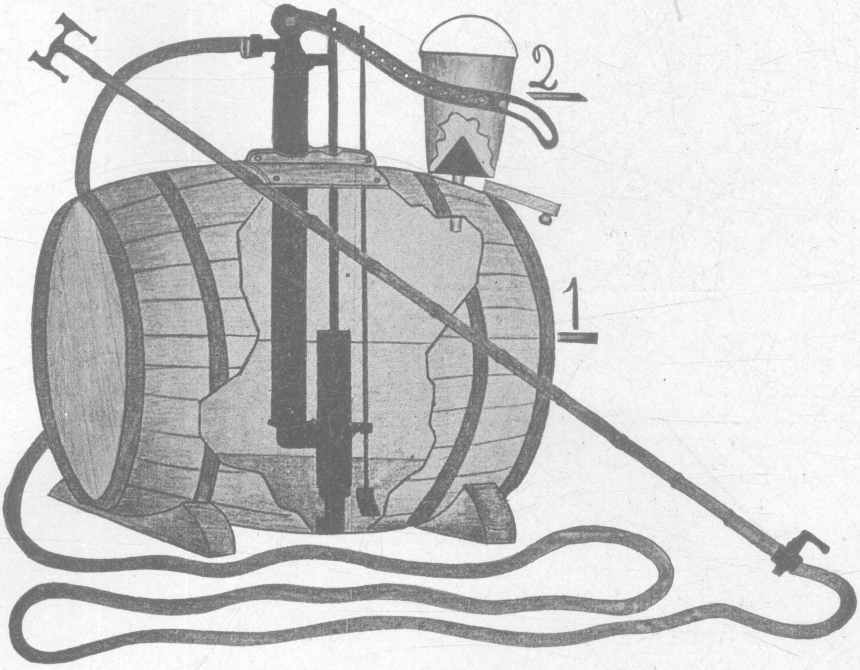
all-brass barrel pump of ample capacity will give good satisfaction. It is advisable to buy a pump of such size that there may be a surplus of capacity rather than one that is insufficient in this respect. The work can be accomplished with less exertion on the part of the operator, and with less wear of the outfit, if the pump be of generous capacity. In choosing a pump make sure, also, that it is fitted with an effective mechanical agitator—an attachment that will keep the spray mixture in the barrel or tank well stirred while the pump is in service. There should be a long line of spray hose—not less than 25 feet if the work would be most easily and readily done. There should be an extension tube 8, 10, or 12 feet in length, according to size of the trees to be sprayed. The best form of extension tube is made of bamboo with a brass or aluminum tube running inside and connecting the hose at the base of the rod with the spray nozzle at the point. There should be a stop-cock at the base of the rod where it connects with the hose.



Sprayed and unsprayed Rome Beauties just as they came from the trees

A well-made barrel of 50 gallons capacity is recommended for the home orchard. A vinegar or kerosene barrel will serve the purpose well. A number of buckets will be needed—wooden buckets are by all means to be preferred—and these may be purchased very cheaply of any candy dealer.

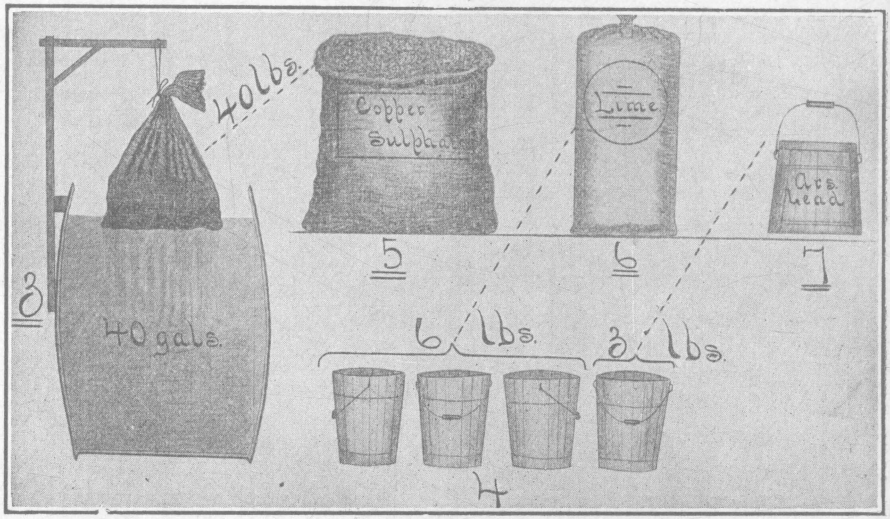
Another indispensable part of a spraying outfit is a suitable strainer, through which to strain the spray mixtures into the barrel or tank, thereby preventing trouble from clogging of the nozzles of the outfit. A very simple, efficient and inexpensive strainer may be made of a common 10-quart galvanized iron bucket which may be purchased of almost any hardware dealer. Have the tinner cut a round hole 1 ¼ inches in diameter in the center of the bottom of the bucket, over which, on the outside of the bottom, have soldered a tube of the same diameter, six inches in length, On the inside of the bucket, covering the opening in the bottom, have soldered a cone of very finely perforated sheet brass, such as is used over the ends of pump rods in driven wells. The cone should be about 5 or 6 inches in diameter at the base and the same in height. Such a strainer will not clog when the materials are strained through it—the sediment rushing off to the base of the cone while the central part remains open and unobstructed.



Spraying outfit for small orchard. An outfit of this type should cost not exceeding $20.00

The materials necessary for spraying for fungous diseases and leaf and fruit destroying parasites are copper sulphate, (blue vitriol) lime and arsenate of lead. Copper sulphate is purchased in crystal form by the barrel of 400 or more pounds, or in lesser

quantities as the buyer may choose. The most convenient form of lime is the "hydrated" or "ready-slaked" builders' lime which is put on the market in airtight paper bags, and may be procured from almost any of the larger builders' supply firms. Fresh burned stone lime is excellent, but requires the additional trouble of slaking. The arsenate of lead is in paste form and is sold in barrels, kegs or buckets according to the quantity desired.



Equipment and materials necessary for spraying small orchards

FORMULA FOR THE BORDEAUX MIXTURE

Copper sulphate [blue vitrol] ..... 4 lbs.
Lime [hydrated] ..... 6 lbs.
Water to make ..... 50 gals.
Note: If fresh-burned stone lime be used 4 or 5 lbs. will be sufficient.

Where considerable spraying is to be done it is a great saving of time and work to make up a *stock solution* of copper sulphate. This requires a second barrel which should be provided with a good cover. Let us suppose that this "stock" barrel is of 50 gallons capacity: into it pour 40 gallons of water. Then weigh out, in a burlap bag, 40 lbs. of copper sulphate—or just as many pounds as there are gallons of water in the "stock" barrel. Now suspend the bag of copper sulphate in such a manner that its bottom will extend an inch or two (not more) down into the water. In this position the copper sulphate will readily dissolve over night, or less time. The mistake is often made by the beginner of hanging the bag of copper down deep in the water—submerging it. This mistake will result in the copper dissolving very slowly; a part of it may not dissolve at

all, as the water near the bottom soon becomes a "saturated solution" or, in other words, so heavily charged with copper that it loses its dissolving power. With the bag of copper sulphate suspended as advised, with its bottom merely touching the surface of the clear water which remains at the top, dissolution continues unrestricted until the contents are entirely reduced.

MAKING THE BORDEAUX MIXTURE

In preparing a 50 gallon barrel of Bordeaux, measure out from the "stock solution" 4 gallons, straining it into the spray barrel. Immediately dilute this quantity by adding enough water to make the barrel at least half full. Do this before adding the lime—it is important. If the mistake should be made of adding the lime to the strong solution of copper as it comes from the "stock" barrel, a curdled mass would most likely result—one that would not be so effective as a spray and one that might give trouble by clogging the spray nozzles. The spray barrel now being half full of the weakened copper solution it is ready for the lime. Weigh out 6 lbs. of hydrated lime and mix with water by stirring. Continue adding water and stirring and pouring into the several buckets until a quantity of 10 or 12 gallons of thin whitewash or milk of lime is obtained. Then slowly strain this thin lime solution into the spray barrel, briskly stirring the contents with the agitator of the pump whose plunger rod has been disconnected from the handle. This will result in the formation of a bright, sky-blue mixture free from curdling. The arsenate of lead should next be added. Weigh out 3 lbs. of lead, add a little water and stir briskly until it becomes a thin paste. Continue adding water and stirring until the solution is of such consistency as to readily go through the strainer into the spray barrel. Thoroughly agitate the mixture again just before beginning to spray after reaching the orchard.

THE TIME TO SPRAY APPLES

Give the *first spraying* just before the blossom buds open. The arsenate of lead may be omitted from this spraying.

The *second spraying* should be given as soon as the blossoms have fallen and while the little apples are yet remaining in upright position. Use the arsenate of lead in the Bordeaux for this spraying.

Give the *third spraying* ten days or two weeks after the second, using both arsenate of lead and Bordeaux again.

If a fourth spraying be given, which is almost always profitable, use the arsenate of lead alone about the 1st to 15th of July. This late spraying is to kill the second brood of the codling worm and to thereby prevent the "winter wormy fruit."

Spray the tree thoroughly—until every leaf, twig and branch is fully covered and beginning to drip. It may require 6, 8 or even 10 gallons of spray mixture to so fully spray a large tree, but count the time and material well spent.

The cost of spraying will range from 50 cents per tree, for 25- or 30-year-old trees, down to 15 cents per tree for 10- to 12-year-old trees for the season of three sprayings, this including the cost of the material and the labor. The fourth spraying would add a small amount to these estimates. The benefits to be derived from of this expenditure of material and labor may be realized by a reference to the tabulated results of the Experiment Station's demonstrative work in south-eastern Ohio during the season of 1909, as recorded on succeding pages of this bulletin.

While the Bordeaux mixture has been the panacea for nearly all fungous troubles for a number of years and no doubt will continue to be largely used for some time to come, it is not, in some respects, a perfectly satisfactory fungicide. The Bordeaux mixture, especially in very rainy seasons, is likely to do some injury both to foliage and fruit, though by no means to such an extent as the diseases for which it is applied. Some of the leaves of apple trees turn yellow and drop prematurely and Bordeaux mixture aggravates this trouble; and it has a tendency to russet the fruit of some of the more susceptible varieties of apples. However, in case of the Rome Beauty, the predominating variety in southern Ohio, the Bordeaux is an almost perfect remedy for the scab and other fungi which so seriously affect it. This variety requires a strong fungicide and nobly responds to it, rarely showing a trace of injury by russeting of the fruit from the use of the standard strength of Bordeaux.

Our scientific men have not ceased their investigation and experiments in seeking a still more perfect fungicide, and their labors promise to be—possibly already are—rewarded. There is strong probability that the commercial preparation of lime and sulphur will gradually take the place of Bordeaux mixture, aside from its being the standard remedy against the San Jose scale.

A thorough and more extended test of lime-sulphur in comparison with Bordeaux will be at once inaugurated under various conditions and on many varieties of apples found and grown in Ohio.

Thinning

A new problem promptly presents itself along with the first results of thorough work in spraying —overloading of the trees with fruit. The trees set and persistently retain, oftentimes, twice, thrice or four times the number of apples that they can mature. Where these conditions occur there is no work that will pay better returns than carefully thinning the fruit. A surplus apple or a defective apple should be considered as a "weed apple", as it will not only be worthless itself, but will prevent the fullest development of the perfect apples which it crowds. It is an excellent plan to relieve overloaded trees by removing the defective apples and thinning those remaining until they hang from 6 to 8 inches apart. The total quantity in bushels, at picking time, will not be appreciably lessened, because individual specimens of the smaller number of apples will attain much larger size.

In addition to the profitable results of thinning, so far as the size and quality of the fruit is concerned, the effect is very beneficial to the trees in various ways, assisting them materially in retaining health and vigor and promoting in a greater or lesser degree a regularity of crop production.

In Conclusion

It has been endeavored, in this chapter, to briefly discuss the essentials of apple culture in a way that will be helpful to the many orchard owners who are awakening to the possibilities which lie within their reach. The writer has dealt only with the principles which enter into *production* of sound, perfect, profitable fruit. Cultural essentials by no means cover all the important factors of successful apple growing. After the crop has been produced a very great deal depends upon how it is handled. Picking, grading, packing, storing and marketing constitute a remarkably promising field for individual resource and ability from a business standpoint. But this is another story.

REPORT OF DEMONSTRATIVE WORK IN WASHINGTON COUNTY, 1909. SPRAYING FOR CONTROL OF APPLE SCAB

A once profitable industry in southern Ohio; its downfall

Various localities in the eastern and southern portions of Ohio were, at one time, prominent as apple producing sections. Especially were the counties bordering the Ohio river noted for the great quantity and fine quality of their Rome Beauties, Roxbury Russets (known locally as "Putnam", "Marietta" or "Belpre" Russets) and a few other varieties, grown

along the valley and back among the hills, and shipped by thousands of barrels annually in barges which carried them to southern markets and, to some extent, to the more adjacent markets of Pittsburg, Wheeling and Cincinnati.

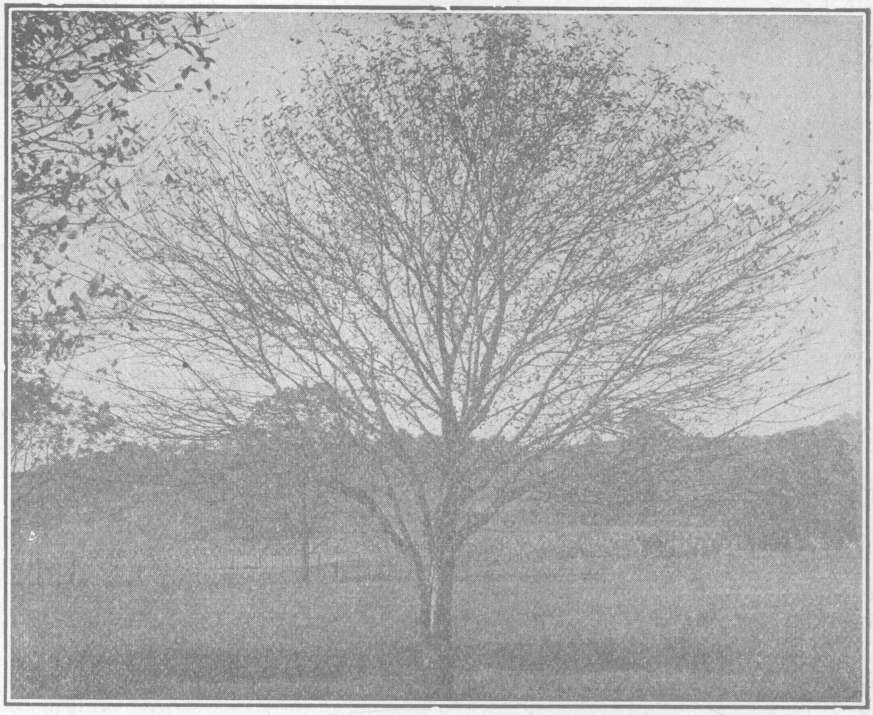
In those early days the fruit grew perfect and beautiful, and production seemed limited only by the extent of the acreage. For these great crops, handled by methods similar to those now employed in moving potatoes in large bulk, very low prices were obtained, as compared with prices ruling at the present time for stock of like quality. Nevertheless, the apple orchards of the southern part of Ohio brought to their owners satisfactory returns for the remarkably small outlay of labor, time and expense incurred in their maintenance. It was an epoch of prosperous and happy days; but the very ease with which fine apples were grown fostered indifferent methods of orchard management, and illy prepared the more thoughtless and careless owners for the problems which were slowly but surely developing for the future and which have, indeed, proved to effectually baffle by far the greater number of growers, and to bring a rapidly growing industry to an abrupt and humiliating termination. So long as the orchards remained fruitful under the easy-going manner in which they were maintained, apple trees were freely planted; but with the advent of trouble, which came as a natural sequence of neglect to combat threatening elements of stealthy approach, planting of orchards was almost entirely discontinued.

Within quite recent years utter discouragement has fallen upon this once thriving section, with the exception of here and there an individual orchardist who has closely and studiously followed the work of our scientific investigators, and promptly availed himself of such measures of relief as have from time to time developed.

An inquiry by the Ohio Experiment Station

In the winter of 1908–9 the Experiment Station sent out many letters to orchard owners in the southern part of Ohio, requesting that those who possessed apple orchards and were yet interested in orchard improvement, would respond by writing the Station stating their acreage in apples, the condition of the trees and soils, what was being done to improve those conditions, and any other information that might enable the Experiment Station to get into closer touch with the once successful but now inactive orchardists. But few replies to these letters were received—these coming from widely scattered points. As an instance which will especially serve to point this fact it may be stated that from Washington county, south-eastern Ohio, there came

responses from but three orchard owners. This was a most surprising thing, inasmuch as it was known that Washington county was at one time the foremost apple producing county in Ohio, with over 7000 acres of apple orchards, or nearly double that of the average counties of the state. It was therefore arranged that a representative of the Horticultural Department of the Station should make a visit of inspection to Washington county, study conditions, gain the viewpoint of the discouraged orchardists and recommend such measures, both to the growers and to the Station, as might seem necessary to give relief.



Defoliation by apple scab fungus. Photo taken September 16, 1909

Apple scab fungus scourge of southern Ohio orchards

Accordingly the writer proceeded to Washington county, first going direct to the farms of the three gentlemen who had responded to our letters of inquiry, and subsequently mingling with many other orchard owners with whom we had not, previously, had any acquaintance or communication.

Various reasons were given, by these south-eastern Ohio orchard owners, for the comparatively recent failure of their trees to bear fruit as formerly. They stated that the trees continued to bloom profusely, as a rule, and appeared most promising early in the spring; but that the blossoms would wither, dry up and fall, or the little apples turn yellow, die and drop. It was explained, moreover, that the foliage of the trees would, later in the season, become spotted, yellowish and sickly and drop prematurely. That the few apples which did succeed in hanging on the trees were hard, gnarled, scabbed, blackened and almost worthless. The reasons given for these deplorable conditions were almost as various as the several growers visited. Some attributed the trouble to warm periods of weather in February or March, followed by extreme cold; others to cold winds in April and May; others to cold rains during the same months; others to late frosts; others to a gradually changing climate in general. A number of growers declared their belief that the varieties so long grown in that section had "run out"; that the Rome Beauty—the variety greatly predominating throughout south-eastern Ohio—had so deteriorated that it was no longer worthy of planting. Those who had orchards in the Ohio river valley or the lower levels of the smaller valleys opening into the valley of the Ohio, were confident that it was no longer of any use to attempt to grow apples, because the fruit was rendered black and worthless by "fog stain" even when it partially escaped the more serious, accompany; ing trouble which distorted, scabbed and dwarfed its development.

Listening, it is trusted, with ample patience and surely with much real sympathy to these complaints which, while varied somewhat, gave an unmistakable clue to the real trouble, the writer made a note of these facts: First and foremost that practically no spraying had been done, and that the few who had attempted it had either worked with inefficient outfits or with improperly made mixtures, or both; that southern Ohio had simply entered upon an era of a terrific scourge of fungous diseases of the apple, which the climate of that section especially favors; that the apple scab fungus was the principal cause of the withering and dropping of the blossoms and newly-set fruits and the spotting, yellowing, browning and premature dropping of the foliage; that the sooty-blotch or fungus was responsible for the "fog-stains" which besmirched the apples in the low levels, where the humidity of the atmosphere highly favors its development; that the codling moth and curculio came in for their share in destruction, and swept away such remaining portions of fruit as partially or wholly escaped the

fungous diseases; that the greatest error into which the orchard owners had fallen was their belief that the Rome Beauty and other erstwhile dependable varieties of apples had "run out." The fact should here be emphasized that there is, so far, no variety known that is so excellently adapted to southern Ohio (its home), and none that so easily, quickly and generously responds to spraying as the Rome Beauty. It is seriously subject to fungous disease of both foliage and fruit, but it is the embodiment of perfection when properly sprayed.

The Experiment Station to the rescue

Hastening a report of conditions back to the Horticultural Department of the Station, recommendation was made that a few simple but efficient spraying outfits, with chemicals, be rushed to Washington county, where a number of demonstrations in fungus and insect control might be made in at least the orchards of the three men who had responded to the Station's letters of inquiry. As the time for spraying was at hand by the time the outfits and materials arrived at their destination, Station employes followed and personally made and applied the mixtures, spraying representative blocks of each orchard, chosen for the demonstrations. The owners co-operated by furnishing the necessary teams and drivers, and closely observed the making of the mixtures and the thoroughness of the applications. Rows or single trees were left unsprayed as "checks" for comparison with the sprayed rows or trees. The greatest of care was taken in the choice of these check trees, that only such as were fully equal to the best of the trees to be sprayed, might be selected. In every case the check trees had blossomed as profusely and were apparently as vigorous as the trees sprayed alongside. The first spraying was given as soon as the petals of the blossoms had fallen. We should have preferred to make this first spraying just before the blossom buds opened, but it was too late by the time the outfits were at hand.

Very soon a distinct difference was apparent between the sprayed and unsprayed trees. The little apples on the sprayed trees promptly sprang into evidence plump, bright and persistent. From the unsprayed trees the little fruits dropped by thousands, withered and yellow from the early attack of the apple scab fungus; the ones remaining soon began to develop rough, darkened spots that enlarged until the fruits were gnarled and deformed. A second spraying was given two weeks after the first, and a third and last about the first of July.

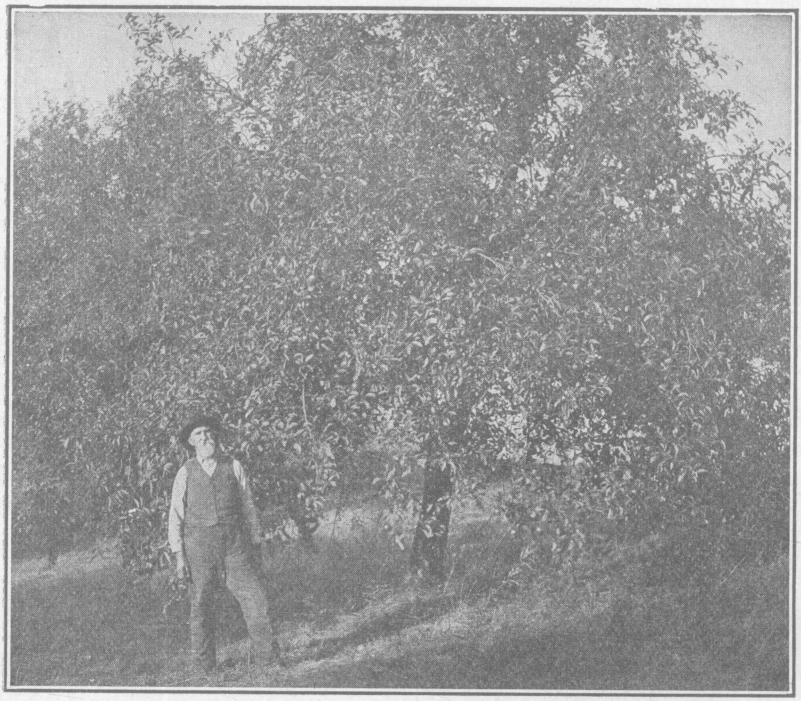
As the season advanced the difference between the sprayed and unsprayed tree became more and more clearly marked. In June the sooty fungus came with alarming severity, sweeping through the valley orchards and blackening the unsprayed and already otherwise terribly deformed fruit; but the three thorough sprayings kept the heavy loads of apples on the treated plots smooth, bright, plump and perfect. The results of this thorough spraying were simply marvellous when it is considered that it was the first season's work in the very midst of one of the most seriously disease and insect infested areas in Ohio. In addition to keeping the fruit remarkably free from the dreaded scab fungus, there was practically no evidence of sooty fungus, and the codling worms and curculio which were in generous evidence among the unsprayed apples were almost entirely barred from operations in the sprayed sections.

DETAILS AS TO ORCHARDS AND SPRAYING IN WASHINGTON COUNTY

The orchards; the owners; the location

The orchards included in the demonstrative work in spraying, in 1909, were those of J. C. O'Neal, of Belpre, J. H. Riggs, of Little Hocking, and Chas. W. Oakes, of Armenia—all within sight of the Ohio river, and either within its valley or upon the adjacent hilltops.

The O'Neal orchard is situated on a very high hill. one mile north of Belpre and overlooking the Ohio River and valley and the town and city of Belpre, Ohio, and Parkersburg, W. Va. The land on which the orchard is located is thin, is in grass and had been pastured for a number of years. The location exposed the trees to extremes of cold and heat, and they had especially suffered from protracted droughts, which baked and parched and cracked open the thin, hard soil of the hilltop. The trees were 30 years old. The orchard was at one time generously fruitful of beautiful Rome Beauties and a few other varieties, the apples attaining very high color because of the elevation, exposure to sunshine and the peculiar red clay soil which abounds at certain elevations throughout that section; but in recent years it had not produced enough sound fruit for the home use of the owner. This orchard, in 1909, did not blossom uniformly, presumably from the effects of the very severe drought of the preceding season—only the more favorably situated trees being enabled to form fruit buds. Previous onslaughts of apple scab had also done much to devitalize the trees by destroying the foliage early in the season. A number of the trees bloomed profusely, quite a proportion scatteringly and a few

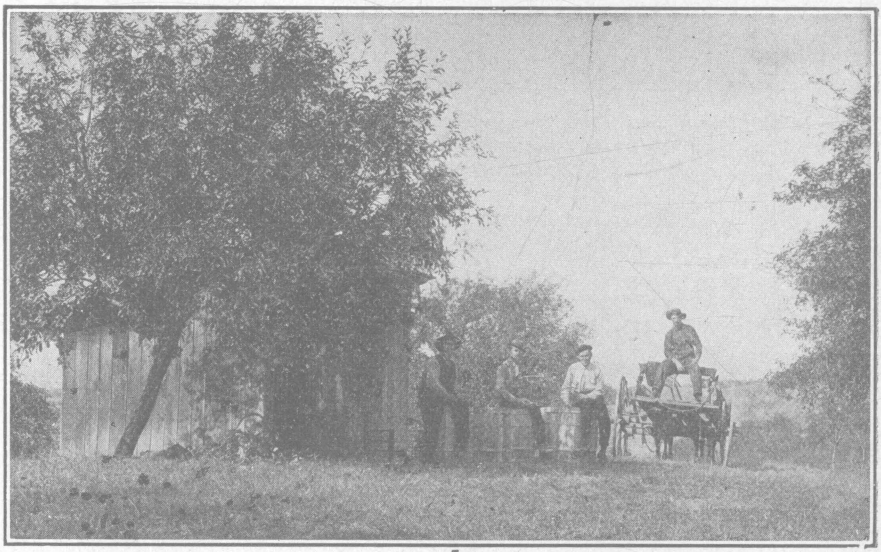


A Rome Beauty tree after years of crop failures through infestation of fungi and insects, bearing a crop of 12 bushels of sound, perfect, long-keeping apples.
Orchard of J. C. O'Neal, Belpre

not at all. Mr. O'Neal expressed his opinion that never again would he be privileged to see his trees produce sound, perfect fruit. Much to his surprise and delight, however, the trees which had blossomed freely and were thoroughly sprayed produced remarkably heavy crops of as fine or finer fruit than he remembered ever to have seen in the early years of the orchard. The trees which bloomed sparsely and were sprayed bore a partial crop of equally fine fruit, while the unsprayed trees, no matter how profusely they had blossomed, bore but a very insignificant quantity of miserably deformed, scabby, worthless specimens, which he considered not worth picking. From the sprayed trees Mr. O'Neal had the pleasure of gathering and storing over 100 bushels of choice apples which he sold to his neighbors in the village at $1.00 per bushel without grading. Mr. O'Neal sees renewed possibilities and opportunities in this excellent orchard and is preparing to spray and otherwise care for it in the future. He is using his entire crop of corn stover, grown upon the hill in a field adjoining, for mulching

his trees which have heretofore been suffering from lack of food and moisture, and declares that he is confident that this fodder, used as a mulch, will bring him far greater results than selling it at the usual prevailing prices.

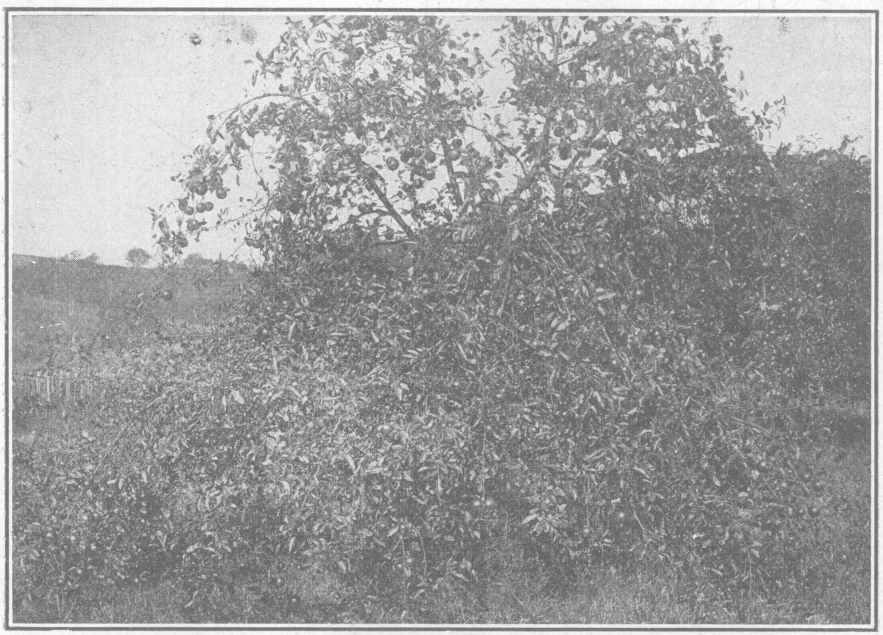
An excellent water supply was available in Mr. O'Neal's hilltop orchard. Having become wholly discouraged with his orchard he utilized the area for pasture. As no water was in the orchard he built a large cistern on the summit of the hill. Over the opening of this cistern extends one end of a shed probably 12x18 feet in size. This shed is covered with galvanized steel roofing, and an eavestrough is attached by which water from rains and melting snows is conducted into the cistern. So convenient was this water supply, and so valuable a suggestion for other owners of hilltop orchards, that attention is called to this feature as one worthy of following elsewhere. The shed, aside from supplying the cistern with water, provides shelter for tools, spraying equipment, barrels, crates, baskets, and workmen in time of rain.



A high hill top in Washington county. The water for use in spraying this orchard is gathered into a large cistern, the curb of which is just inside the orchard tool-house. Orchard of J. C. O'Neal, Belpre

The Riggs orchard is situated 8 miles farther down the Ohio river and one mile from the station of Little Hocking. This orchard is also located on a high hill. The trees were 12 years old and of Rome Beauty and Ben Davis varieties. While the trees of this orchard had been blooming profusely since they were seven or

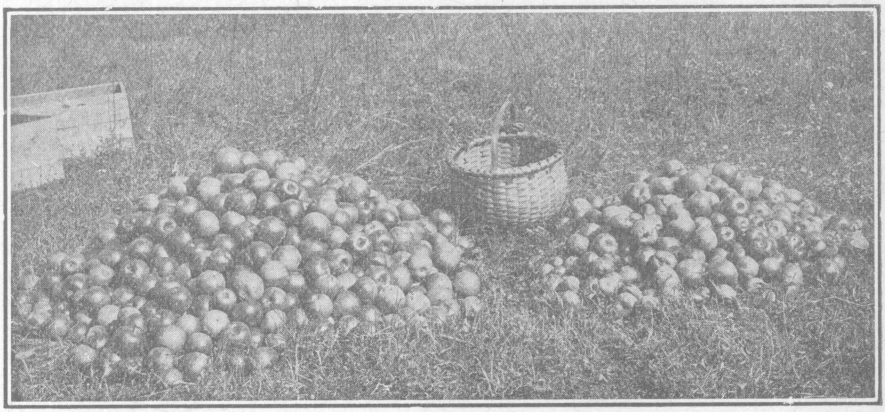
eight years old, and had borne some fruit, the fruit had been defective from scab, sooty fungus, codling worms and curculios. The orchard was used for a pasture, but had received occasional top-dressings of manure hauled from a cattle shed nearby. About one acre of this orchard was sprayed, leaving in each row a "check" tree carefully chosen because of its average size, good health and vigor and profusion of bloom. The object lesson afforded by this orchard, showing the benefits of thorough spraying, was simply marvellous, as may be observed by reference to the tables showing yields and quality of products from sprayed and unsprayed trees.



Results of thorough spraying. A 12-year-old tree from which over 300 apples were thinned

The Oakes orchard is situated 10 miles below Belpre and on second bottom, Ohio river valley land. The trees, 450 in number, were 34 years old. This orchard had been widely noted for its abundant prolificacy of extra large Rome Beauties, which almost wholly compose the plantation, but had not borne perfect fruit in late years on account of the prevalence of apple scab and serious, annual infestation of sooty fungus, invited by the humidity of the valley conditions. This orchard was also being continually pastured. The owner was very much discouraged because of repeated failures of the orchard to bear and was seriously contemplating the cutting it down. In fact the only reason that

the trees were yet standing in the spring of 1909 was that Mr. Oakes failed to find anyone who would accept his offer of the timber for the work of cutting down the trees. A representative acre of this orchard was chosen by the Experiment Station, having obtained the consent of the owner to do some demonstrative work. Mr. Oakes himself assisted in locating this demonstration plot, and especially in determining the check trees to be left, so that he would know that the trees left unsprayed for comparison were fully equal in every respect to those to be sprayed. The trees were in full bloom when this selection was made. The result of this demonstration was that from the one acre sprayed Mr. Oakes sold over $500 worth of fine Rome Beauties, leaving a net profit for the acre of $474, after all expenses had been deducted. This object lesson was seen and studied by hundreds of orchard owners of southern Ohio during the season of 1909. The autumn meeting of the Ohio State Horticultural Society was held in the orchard, and numerous exhibits of sprayed and unsprayed apples therefrom made at Marietta, Barlow and elsewhere, including the State Fair at Columbus and the January, 1910, Apple Show in connection with the Annual Meeting of the State Horticultural Society. The results, personally, with Mr. Oakes, are that a new, power spraying outfit is already on the ground, and plans for the most excellent care of the old orchard are being formulated as well as plans for planting many acres of new orchard on adjacent land. Mr. Oakes stated that his *unsprayed* trees, in 1909, bore such poor, worthless fruit that he could not easily encourage his pickers to get up into the trees after it.



Sprayed		Unsprayed	
Sound and perfect	560	Sound	0

Products of two Rome Beauty trees twelve years old. Fifteen cents worth of material and labor made the difference

An enthusiastic autumn meeting of the Ohio State Horticultural Society, in orchard of Mr. Chas. W. Oakes, Armenia

A tabulated statement of results of spraying in these various orchards follows. In making comparisons between sprayed trees, those of the same age and as nearly same size and degree of vigor as it was possible to determine, were chosen. Happily it was also possible to select these average trees so that they stood side by side in the O'Neal and Riggs orchards, and but a very short distance apart in the Oakes orchard. No fairer comparisons could reasonably be desired.

Brief summary of results of spraying in Washington County in 1909

The spraying was done principally with Standard Bordeaux mixture as the fungicide and arsenate of lead as the insecticide. However, in a few instances, half strength Bordeaux with arsenate of lead, half strength Bordeaux with sulphate of iron and arsenate of lead, and full strength Bordeaux with arsenate of soda were used. The first three tables present the results of one representative comparison between sprayed and unsprayed trees in each orchard—this comparison representing average conditions as nearly as could possibly be determined—where standard Bordeaux (4-6-50) and arsenate of lead (3 lbs.) were used.

In every case cost of crop includes materials for spraying, the work of spraying, the barrels, the picking and packing.

ORCHARD OF J. C. O'NEAL, BELPRE. TREES 25 OR 30 YEARS OLD

Variety Rome Beauty	Sprayed Tree No. 1	Unsprayed Tree No. 2
Sound, perfect apples	1445	4
Very slightly scabbed	591	53
Total marketable	2036	57
Cost of spraying three times	$0.50	....
Total product in barrels	5 1-3	2-3 bbl.
Total value of crop	$16.00	$0.40
Total cost of crop	2.70	0.65
Net profit	$13.30	—$0.25

ORCHARD OF J. H. RIGGS, LITTLE HOCKING. TREES 12 YEARS OLD

Variety Rome Beauty	Sprayed Tree No. 1	Unsprayed Tree No. 2
Sound, perfect apples	560	0
Very slightly scabbed	142	55
Total marketable	702	55
Cost of spraying three times	$0.15	....
Total product in barrels	2 1-6	3-4 bbl.
Total value of crop	$8.66	$0.75
Total cost of crop	1.13	$0.48
Net profit	$7.53	$0.27

ORCHARD OF CHAS. W. OAKES, ARMENIA. TREES 34 YEARS OLD

Variety Rome Beauty	Sprayed Tree No. 1	Unsprayed Tree No. 2
Sound, perfect apples	1530	2 (mk'd sooty fg
Very slightly scabbed	400	337
Covered with sooty fungus	37	966 (100 %)
Total marketable	1893 (1st class)	337 (2nd class)
Cost of spraying three times	$0.50	....
Total product in barrels	4 3-4	1 1-4 bbl.
Total value of crop	$14.25	$2.19
Total cost of crop	2.60	.70
Net profits	$11.65	$1.49

An additional table showing results of spraying with different quantities and combination of materials is given below. Three counts were made from as many representative trees 34 years old.

There was very little evidence of presence of codling worms in this orchard.

ORCHARD OF CHAS. W. OAKES; VARIETY ROME BEAUTY

Character of fruit	Sprayed Standard Bordeaux and arsenate of lead %	Sprayed Standard Bordeaux and arsenite of soda %	Sprayed One-half strength Bordeaux and iron sticker %	Unsprayed Check tree %
Sound, perfect fruit	81.8+	92.3+	80.5+	00.2+
Very slightly scabbed	14.2	5.6	12.6	35.8
Deformed by scab	3.2	2.0	1.2	60.7
Marked with sooty fungus	0.6	0.0	5.3	100.0
Injured by codling worm	0.0	0.0	0.2	3.2

Following is a summary of results of spraying for control of apple scab in Washington county, 1909. The figures given present the average percentages of the different grades of apples, based on many counts from different sprayed and unsprayed trees in three different orchards:

	Sprayed %	Unsprayed %
Sound, perfect apples	70	00.8
Very slightly scabbed	17	35.0
Deformed by scab (seconds and cull)	13	74.2

For formulae for making all kinds of spray mixtures for various fungous diseases and insect enemies of fruit and vegetable crops write the Experiment Station at Wooster, Ohio, requesting Spray Calendar (Bulletin 199) which will be mailed free.

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